III. REMARKS

The Examiner rejected claims 1, 5-12 and 16-32 under 35 U.S.C. 103(a) as being unpatentable over Makino et al. (US Patent No. 626760), hereinafter referred to as Makino, in view of Brennan et al. (US Patent No. 6240192), hereinafter referred to as Brennan.

The present application discloses, *inter alia*, a SAF system including an oversampled analysis filterbank for transforming a primary signal and a reference signal to frequency domain primary signals and frequency domain reference signals in a plurality of subbands, and a processor for processing the frequency domain primary signals and the frequency domain reference signals in the subbands. The processor includes an adaptive filter in each subband and a module for operating on at least the frequency domain reference signal to improve the convergence of each subband adaptive filter. The present application discloses several convergence techniques of improving the convergence of each subband adaptive filter, including whitening by spectral emphasis in the subband domain and whitening by decimation in the subband domain.

Employing oversampled filterbank for subband adaptive filtering encounters a convergence problem due to oversampling (e.g., aliasing distortion, coloration of subband signals). The present application addresses, *inter alia*, the solution of this problem. According to the present application, the oversampled subband signals are whitened to increase the convergence rate of the subband adaptive filters. Therefore, the inherent benefit of decreased spectral dynamics resulting from subband decomposition is not lost due to oversampling. *See* page 6, the second paragraph of the original specification (Paragraph [0037] of the corresponding US Patent Application Publication).

In particular, the whitening by decimation (after subband decomposition) improves the convergence rate of the subband adaptive filter by increasing the effective bandwidth of the reference signal, and the whitening by spectral emphasis (after subband

decomposition) improves the convergence rate of the subband adaptive filter by limiting the stop band loss thereby increasing the smallest eigenvalues. *See* page 13, lines 4-9 of the original specification (Paragraph [0072] of the corresponding US Patent Application Publication). This allows the faster convergence of the subband adaptive filter. Claims 1 and 12 have been amended to specify processing subband signals produced by oversampling including whitening by spectral emphasis and whitening by decimation.

None of the cited references addresses a convergence problem due to oversampling. None of the cited references suggests nor teaches subband adaptive filtering.

With respect to the rejections to claim 1, the Examiners has stated that Makino discloses that the subband signals are whitened in order to increase convergence (Makino, Col. 3, l. 25-35).

Applicant respectfully disagrees with the Examiner. Makino states in Col. 3, l. 25-35 that the projection algorithm (ESP in Makino) removes the autocorrelation of the input signal in time-domain and "hence it means whitening of the signals in the time domain". See Makino, Col. 3, l.30-32). The whitening by the projection algorithm in Makino is applied in time domain. This is further emphasized in Col. 4, l. 55-65 of Makino.

The whitening techniques disclosed in the present application are specifically designed for subband adaptive processing on oversampled filterbanks. This is in contrast to Makino's method that uses a generic property of the ESP algorithm applied in time domain.

Makino further discloses "whitening" in a frequency domain. However, the whitening in frequency domain by Makino is due to subband decomposition, and is not applied to a subband signal after subband decomposition. *See* Makino, Col. 5, l. 5-35 and Col. 11, l.25-37.

The whitening techniques in the present application are applied after subband decomposition and to the subband signal. The oversampled filterbank does not benefit from the whitening of Makino since the oversampling effectively leads to the coloration of subband signals.

As discussed above, employing oversampled filterbank for subband adaptive filtering encounters a convergence problem due to oversampling. This issue is not addressed in any of the cited references including Makino.

With respect to the rejections to claim 1, the Examiner has stated that Brennan discloses a method of improved subband processing for hearing aid functions such as noise reduction (echo cancellation).

Brennan discloses a weighted overlap-add (WOLA) filterbank 16. The filterbank 16 includes a WOLA analysis filterbank 26, a WOLA synthesis filterbank 30, and multipliers 28. *See* Fig. 1 of Brennan. Brennan does not disclose or suggest any subband adaptive filtering. Brennan cannot add any teaching to Makino to render claim 1 unpatentable.

In addition, it is respectfully submitted that noise reduction is different from echo cancellation. In echo cancellation the interference is a replica of the input after some linear/nonlinear filtering and as such correlated with the desired input signal. In noise reduction the interference can generally be produced by any independent source and no assumption is made on the correlation between the input and noise interference. As a result, methods applied to echo cancellation are designed specifically to benefit from the fact that the signal and the interference are produced by the same source(s). Brennan does not disclose or suggest any method of more efficient echo cancellation.

Hence it is respectfully submitted that independent claim 1 is patentable in view of the cited references. It is also submitted that the arguments for claim 1 apply, *mutatis mutandis*, to independent claim 12.

With respect to the rejection to claim 9, the Examiner has stated that the analog/digital converters (A/Ds) disclosed by Brennan inherently have a frequency response and this will act to filter out noise. However, it is a known technical fact that A/D's cannot filter out the in-band noise as they cannot discriminate between signal and noise. The echo cancellation deals with the in-band noise, i.e. the noise in the same frequency band as the desired signal.

With respect to the rejection to claims 11 and 22, the Examiner has stated the signal is a noise signal (echo). However, as discussed above, a noise signal and an echo signal are not the same.

With respect to the rejections to claims 10 and 21, the Examiner has stated that Brennan's subband method comprises two adaptive filters per subband (26, 30 in Fig. 1). However, the elements 26 and 30 in Fig. 1 of Brennan are analysis filterbank and synthesis filterbanks respectively. Brennan does not disclose or suggest "two adaptive filters per subband".

With respect to the rejections to claims 26 and 31, the Examiner has stated that the echo canceller of Brennan acts to adapt filter coefficients to produce an echo estimate to be subtracted from the near-end signal. However, Brennan does not disclose or suggest any adaptive filter coefficients. In Fig. 1 of Brennan, blocks 28 are only multipliers (designated by X) and not adaptive filters. There is no adaptive filter in Fig. 1 of Brennan.

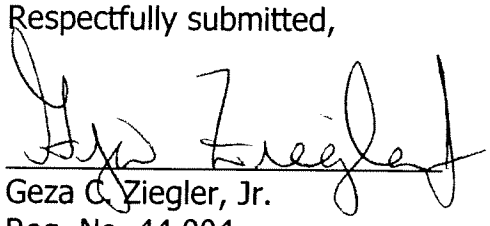
Hence it is respectfully submitted that claims 1 and 12 and their dependent claims are patentable in view of the cited references. Applicant respectfully requests reconsideration and withdrawal of the rejections.

In view of the amendments and the remarks, and having dealt with all the objections raised by the examiner, reconsideration and allowance of the application is courteously requested.

Should any unresolved issues remain, the Examiner is invited to call Applicants' attorney at the telephone number indicated below.

The Commissioner is hereby authorized to charge payment for any fees associated with this communication or credit any over payment to Deposit Account No. 16-1350.

Respectfully submitted,



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23 April 2009
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